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PATENT SPECIFICATION

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(54) ELECTRONIC LOCKING SYSTEM

(71) We, INTERTECH. INC, of 3 Washington Square Village, New York, New York 10012, United States of America, a corporation organised and existing under the laws of the State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an electronic locking system for installation in an entry door.

It is a well-known fact that mechanical locks, such as the pin tumbler lock, deadbolt, and side-bar lock, have security disadvantages in that these locks can be opened by unauthorized persons who have some expertise in this field. It should also be noted that burglars are becoming more and more sophisticated in their techniques of securing entry through locked doors. In order to overcome the drawbacks of mechanical locks, several electro-mechanical locks have been proposed. However, these locks, too, are not considered to completely solve the security problem.

According to the present invention, there is provided an opto-electronic locking system for a closure device having a locking bolt, comprising an optically encoded key, an identically optically encoded element in said closure device and hiden from view, at least one light source for irradiating said key and said element whereby a matrix code is formed having predetermined light levels, a separate light sensor for said key and said element whereby said light levels obtained therefrom are converted to electrical signals, a linearly movable separator positioned between said key and said element whereby, when said key is inserted in said closure device and moved past one light sensor, said separator is engaged and moved and in turn moves said element in a linear direction past the other light sensor, a comparator device for comparing the output of the electric signals from said key to the output of said electric signals from said element, a solenoid for actuating said locking bolt, and an electronic circuit connecting said comparator device with said solenoid, said circuit including an AND gate whereby when the electric signals derived from said key and said element at said AND gate are identical said solenoid is activated to withdraw said locking bolt.

Embodiments of the present invention will now be more particularly described by way of example with reference to the accompanying drawings, in which:—

Fig. 1 is a front elevational view of a key, provided with a matrix code, for an opto-electronic locking system embodying the present invention; and

Fig. 2 is a perspective diagrammatic view of an opto-electronic locking system embodying the present invention.

Referring to the drawings, the opto-electronic locking system utilizes a key 10 which is a simple flat support having a prearranged matrix code 12, as seen in Fig. 1. The key has a suitable optical filter coating on the matrix which prevents direct readout of the prearranged code by any person intending to copy the code. The key 10, as seen in Fig. 2, is inserted in a door D in which a light source 14 is shown that illuminates the key 10. The latter is responsive to light, and according to the prearranged code, segments thereof are either transparent or non-transparent to light thereby forming a predetermined pattern.

Spaced from the key 10 is a duplicate coded flat plate 18, which is illuminated by a light source 16 and which is separated from the key 10 by a separator 20 that serves two functions, i.e., to transmit the linear motion of the key 10 to the duplicate plate 18 and to function as a mechanical barrier between the external and internal sections of the lock. Thus, both the key 10 and the duplicate plate 18 simultaneously move across two appropriately spaced

sensors 26 and 28. The duplicate plate 18 is spring biased to normally be returned to its forward position after it has been pushed rearwardly or into the interior of the door. It will be noted that each of the sensors 26 and 28 is provided with a column of light detectors 22 and 24 which is equal in number to the number of rows in the matrix code on both the key 10 and the duplicate plate 18. Although six detectors are shown in each of the sensors 26 and 28, any suitable number of detectors may be chosen.

The detectors 22 and 24 are of the opto-electronic type in that they translate light levels into electrical signals. Although photo-transistors are contemplated for use in the present system, other suitable detectors may be used, such as photo-voltaic cells or photo resistors.

The key 10 and the duplicate plate 18 are illuminated by the light sources 14 and 16 which are respectively located adjacent to the key 10 and plate 18, and light transmission by transparency is the mode utilized. However, it should be understood that the reflective mode of light transmission may be employed alternatively. It should be noted that the light sources 14 and 16 are activated only by the contacts of a micro switch 32. Thus, the light sources are only activated during operation of the lock, which significantly increases the life of the light sources. It should be apparent from Fig. 2 that as the key 10 is inserted and moves linearly across the sensor 26, the plate 18 moves simultaneously across the sensor 28. The outputs of the detectors 22 and 24 are fed into a comparator 25. The comparator 25 is an electronic logic device which compares each corresponding bit of the output of the detector 22 from the key 10 and the output of the detector 24 from the duplicate plate 18. The output of the comparator 25 is logical true when the corresponding inputs from the key 10 and the duplicate plate 18 have identical logical values, that is, both have the same pattern on the matrix code. On the other hand, the output of the comparator 25 becomes a logical false when the corresponding inputs from the key 10 and the duplicate 18 are not identical. Thereafter, the output of the comparator 25 is fed into an AND gate 30. There are four other auxiliary inputs into the AND gate 30 which clear a flip flop 31 under certain conditions. First auxiliary conditional input into the AND gate 30 is from the light source 16 through a detector 17 and an amplifier 19 into the *d* input of the AND gate 30. The purpose of this input is to prevent false comparison of the key 10 and the duplicate plate 18 due to light source failure. If no light is present at the source 16, then the output of amplifier 19 will be logical false which will clear the flip flop. The second auxiliary conditional input is from an antenna 37 and an inverter amplifier 35 into the input *c* of the gate 30. The purpose of this circuit is to prevent false true setting of the flip flop 31 due to electrical noise. The inputs *a* and *e* into the clear AND gate 30 are used to reset the flip flop 31 after the lock has operated. The flip flop is initially set at a logical true by means of a micro switch 32 and the duplicate plate 18 operates the micro switch 32 at the beginning of the insertion of the key 10 into the lock assembly in the door D. The output of the flip flop 31 is fed into an AND circuit 34. The second input into the AND circuit 34 is from a micro switch 33. The micro switch 33 is operated by the duplicate plate 18 and its output becomes a logical true following the full insertion of the key 10 into the lock. Accordingly, the two inputs into the AND circuit 34 will be logical true only when the key 10 has the same pattern as the duplicate plate 18, the key 10 has been fully inserted, the auxiliary conditions of the light sources are on, and electrical noise is not present. It should be noted that during insertion, if any code of the key 10 does not match the duplicate plate 18, the output of the comparator 25 becomes a logical false, which will clear the flip flop 31.

The output of the AND circuit 34 is thereafter fed into a driver circuit 36 which in turn activates a solenoid 38. The latter withdraws a lock bolt 40 when activated. It should be noted that the solenoid 38 will only become operative when the two inputs into the AND circuit 34 are logical true which occurs only when two basic conditions are met, i.e., the key 10 and the duplicate plate 18 have the same pattern and the key 10 has been fully inserted in the lock so that a complete optical reading can be achieved. In addition to the two basic conditions, there are two other auxiliary conditions which have to be met for the lock to operate, i.e., the light source 16 must be operative during insertion of the key 10 and the inverter amplifier 35 must not sense electrical noise. It should be clear that the auxiliary conditions to be met eliminate erroneous operation of the lock due to false comparison of the matrix codes of the key 10 and the duplicate plate 18 because of light source failure, and also false operation of the lock due to pickup by the system of certain electrical noise. In case either of these conditions is not met, the flip flop 31 is cleared through either amplifier 19 or amplifier 35 and the AND gate 30. When the flip flop 31 clears, the lock will not operate. The system shown in Fig. 2 is a serial decoding electronic lock and must be put in a reset condition after

each unlocking operation. In this regard, the reset condition for the sequential logic of the serial decoding lock is achieved by two operations as follows: The first one is the operation of the solenoid 38 after the proper key is inserted, which activates a micro switch 47. The micro switch 47, when activated, grounds the *e* input of the AND gate 30 which in turn clears the flip flop 31. The second operation is due to the duplicate plate 18 being spring returned to its original place when the key 10 is taken out. The micro switch 32 will be deactivated when the duplicate plate 18 is at its initial position. The contact N.C. on the micro switch 32 will then put a ground clear signal into the *a* input of the AND gate 30 which in turn clears the flip flop 31. The second clear signal is used as a continuous reset condition until the key is inserted again. The first reset signal from the solenoid 38 through the micro switch 47 will be momentary during the opening of the lock.

Furthermore, it is to be understood that although in Fig. 2 light detectors 22 and 24 are shown directly opposite the light sources 14 and 16, it is alternatively feasible to provide suitable optical transmission mediums, such as light guides, for example, fiber optics, lenses, mirrors and the like that can be utilized to transmit the code information from the key 10, and the duplicate plate 18 to the detectors 22 and 24, respectively. Utilization of such optical components as described above allows the detectors 22 and 24 to be placed at any location desired rather than directly opposite the light sources 14 and 16. The key 10 and plate 18 may be irradiated with light from a single light source. It is also to be noted that the power source for the electrical components of the present lock may be of any suitable known kind, such as a normal mains supply or batteries or any suitable combination of these.

Although micro switches are illustrated herein, it is to be understood that other means may be employed to translate the mechanical positional or orientation information into electrical signals, such as magnetic reed switches, proximity switches, and any other suitable switching mechanisms.

WHAT WE CLAIM IS:—

1. An opto-electronic locking system for a closure device having a locking bolt, comprising an optically encoded key, an identically optically encoded element in said closure device and hidden from view, at least one light source for irradiating said key and said element whereby a matrix code of formed having predetermined light levels, a separate light sensor for said key and said element whereby said light levels obtained therefrom are converted to electrical signals, a linearly movable separator positioned between said key and said element whereby, when said key is inserted in said closure device and moved past one light sensor, said separator is engaged and moved and in turn moves said element in a linear direction past the other light sensor, a comparator device for comparing the output of the electric signals from said key to the output of said electric signals from said element, a solenoid for actuating said locking bolt, and an electronic circuit connecting said comparator device with said solenoid, said circuit including an AND gate whereby when the electric signals derived from said key and said element at said AND gate are identical said solenoid is activated to withdraw said locking bolt.

2. An opto-electronic locking system as claimed in claim 1, wherein each of said light sensors is provided with a column of light detectors corresponding in number to the number of rows of said matrix code on both said key and said element.

3. An opto-electronic locking system as claimed in claim 1 further comprising a flip flop device in said electronic circuit to receive the output of said comparator device, and a micro switch for setting said flip flop device at a logical true, the output of said flip flop device being fed into an AND circuit.

4. An opto-electronic locking system as claimed in claim 1, wherein the movement of said key and said element past the light sensors takes place simultaneously.

5. An opto-electronic locking system as claimed in claim 1, wherein said light sensors detect said matrix code in sequential columns.

6. An opto-electronic locking system as claimed in claim 1, wherein said optically encoded key is provided with an optical filter coating to prevent visual readout of the code.

7. An opto-electronic locking system as claimed in claim 1, further provided with means for activating said light source only when said key is inserted in said closure device.

8. An opto-electronic locking system as claimed in claim 3, further provided with a first means which clears the flip flop device if the light source is not operative, and a second means which clears the flip flop device if certain noise is picked up by the locking system.

9. An opto-electronic locking system substantially as hereinbefore described with reference to Figs. 1 and 2 of the accompanying drawings.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

FIG. 1.

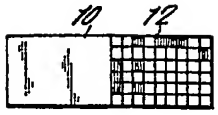

FIG. 2.